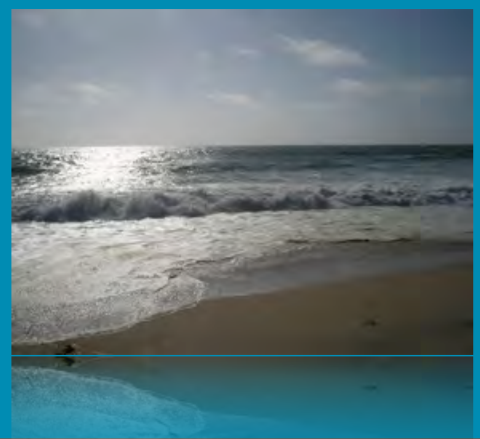
ID # GO25A-03. Abstract # 744915



A Study of Storm-Induced Variability in the Littoral Sediment Transport Patterns of Central Monterey Bay.

J. J. Brower
Moss Landing Marine Laboratories
jbrower@mlml.calstate.edu; (831) 233-0525

1. Introduction

The majority of sediment input to Monterey Bay occurs during episodic winter storms, during which the majority of fluvial input is provided from the Salinas and Pajaro rivers ([1]). Previous estimates of alongshore sediment transport have not properly accounted for either seasonal variability or the possibility of cross canyon transport of sand ([1]). Difficulty in resolution to this problem is caused by the poorly understood sediment yield from rivers and cliff erosion as well as the alongshore transport patterns of sediment within the central bay. Littoral cells transfer sediments from terrigenous sources to shelf and canyon sinks. Heavy mineral assemblages provide insight to erosion, grain motion, and alongshore drift processes in the coastal zone ([2]). The Pajaro and Salinas Rivers transport heavy mineral assemblages, unique to each river, into the Monterey Bay: Sphene and Garnet from the Salinas, Glauchophane and Pyroxene from the Pajaro ([2]). Vector and petrographic comparison was performed to answer the following questions:

1. **What is the distribution of heavy mineral deposits from the Pajaro and Salinas River mouths along the central Monterey Bay coastline, and how does this distribution vary between high and low wave energy seasons?**
2. **What are the sediment transport patterns in central Monterey Bay and do these patterns vary seasonally?**
3. **What are the sources and sinks for coastal sediment in the central Monterey Bay?**

Figure 1: Pajaro and Salinas Rivers
Pictures of Pajaro (left) and Salinas (right) River mouths during summer 2009 sampling.

Abstract

Recent trends in sea level rise threaten both coastal communities and beaches, making it critical to understand sediment resupply patterns along tectonically active, wave-dominated coastlines. Monterey Bay is a unique crescent-shaped embayment with distinct sources and sinks for sediment, but the ephemeral nature of sediment input to the bay makes estimations of alongshore sediment transport patterns difficult, with strong variability over small spatial and temporal scales. This 2009 study focuses on establishing trends of littoral transport and how they vary from summer to winter conditions in the central Monterey Bay area. Littoral transport is estimated using spatial grain size trends and heavy mineral petrography. The Gao and Collins Vector Model was used to estimate transport direction between transect locations, while heavy mineral provenance was traced from the Salinas and Pajaro Rivers to test the estimates of the Vector Model. Littoral transport patterns were found to be largely unaffected by seasonal alterations in incoming swell direction and frequency. Heavy mineral deposition in the study area supports the conclusion that there are two dominant littoral cells in Monterey Bay isolated by the Monterey Canyon. Because the Monterey Canyon acts as a significant barrier to coastal sediment exchange, similarities in coastal composition within the study area is thought to be generated by limited cross-canyon transport and the erosion of both the Aromas and Ft. Ord sandstones.

2. Methods

Sediment samples were collected from four locations within eight transects along central Monterey Bay (Figure 2). Transport between sites A and B is likely if skewness and grain size decrease or increase along with improved sediment sorting ([3], Figure 2). Geometric particle size distributions (0.4 µm – 2 µm) were determined using a Beckman Coulter LS I3 320 Laser Diffraction Particle Size Analyzer. In addition to relative abundances, specific mineral ratios were identified based on optical properties to compare differences in Salinas and Pajaro watersheds including ratios of Hornblende to Garnet from the Salinas and ratios of Hornblende to Sphene from the Pajaro River (Figure 3). Source-rock samples were collected from the upper Pajaro and Salinas Rivers and near Aromas and Marina, California (Figure 3). Rock samples from the upper river channels are collected from or near point-bar deposits, representing the most likely location of deposition within the river channel.

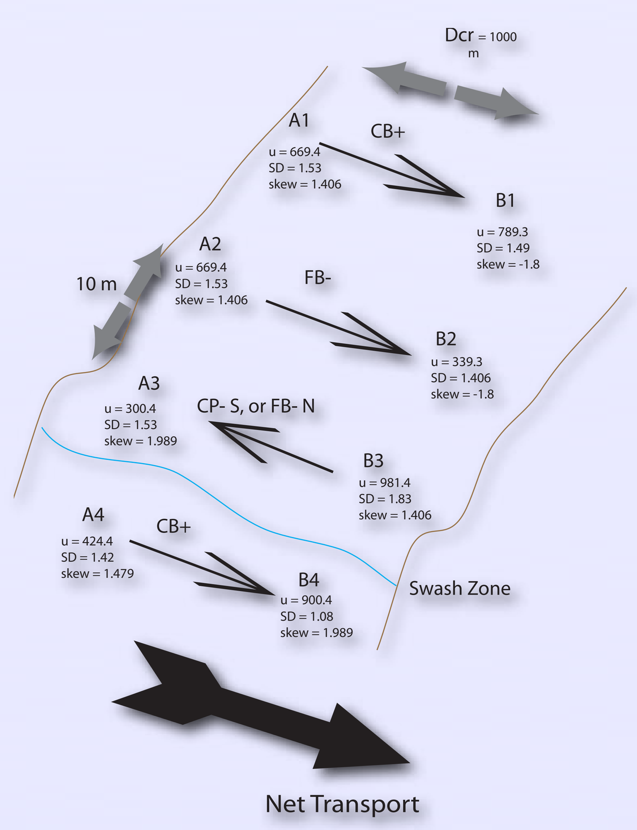


Figure 2: 2D Vector Trend Example
Cartoon representation of net transport between transects A and B. Spacing between transects is about 1 km, and spacing within transect locations (A1 to A2) is 10 m. Diagram is not to scale. Trend vectors calculated based on mean grain size (µ), skewness and sorting / standard deviation. Sediments in the transport direction can either be finer with no increase in skewness (FB-) or coarser with no decrease in skewness (CB+) ([3]).

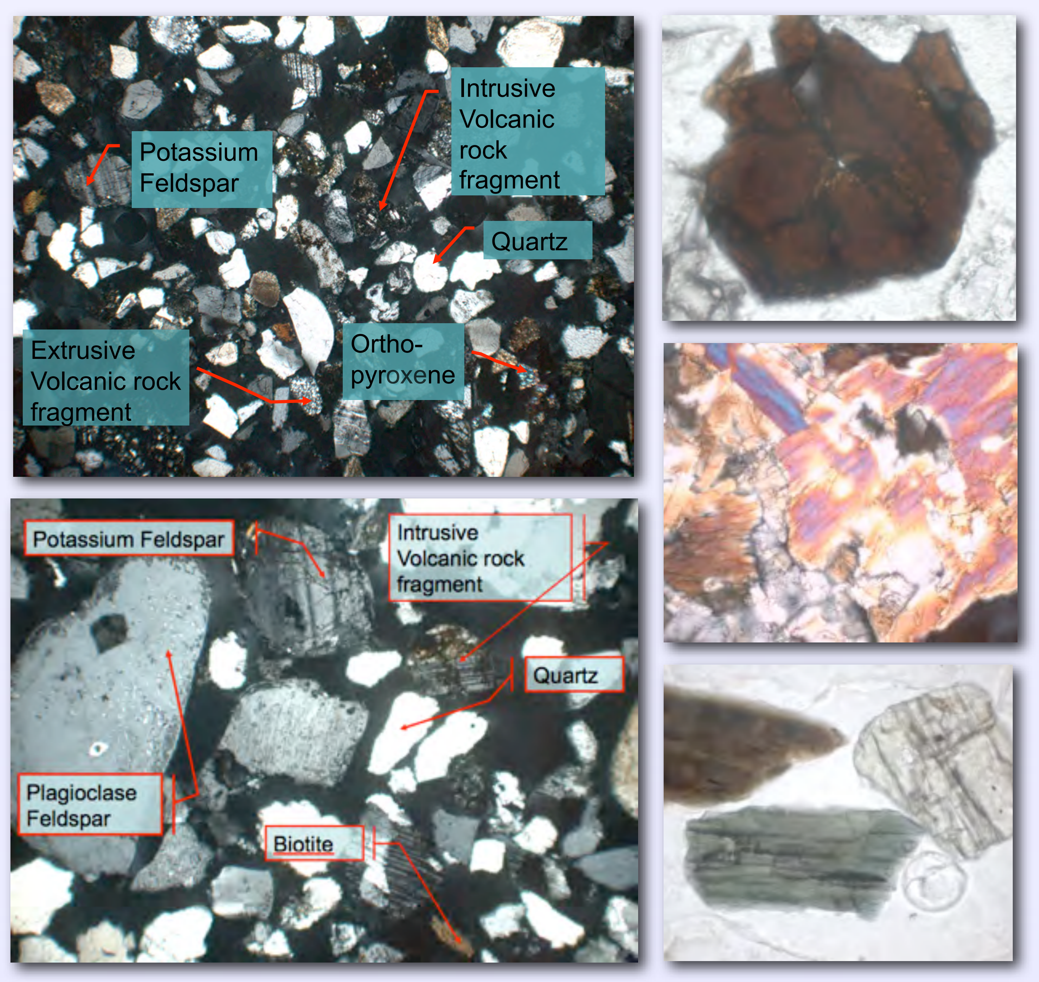


Figure 3: Petrographic Analysis of Littoral Sediment
Sediment provenance is determined by the distribution, sorting and maturity of minerals collected from swash zone samples. Quartz, Feldspars, Lithics, accessory and heavy minerals are visible in a Pajaro River Mouth sample (top left). Intrusive volcanic fragments dominate a sample from the Salinas River mouth (bottom left)Top left: Garnet fragment from the Salinas. Top right: Clinopyroxene from the Pajaro. Middle right: Biotite (top left), Hornblende (middle) and Orthopyroxene (right) in Plain Polarized light.

3. Results

1) Heavy Mineral Trends
Pyroxene and Hornblende was found along the majority of the central coast in both summer and fall samples (Figure 4 A-B). Pyroxenes and Hornblende were found consistently along the coast, with a decreased in relative abundance from the northern to southern transects during both summer and fall seasons (Figure 4 A-B). Heavy mineral concentrations decreased to the north and south of the Pajaro River Mouth in the Fall, and increased during the summer, with the highest concentrations recorded 2 km south of the Pajaro River mouth and 1 km north of the Salinas River Mouth (Figure 6).

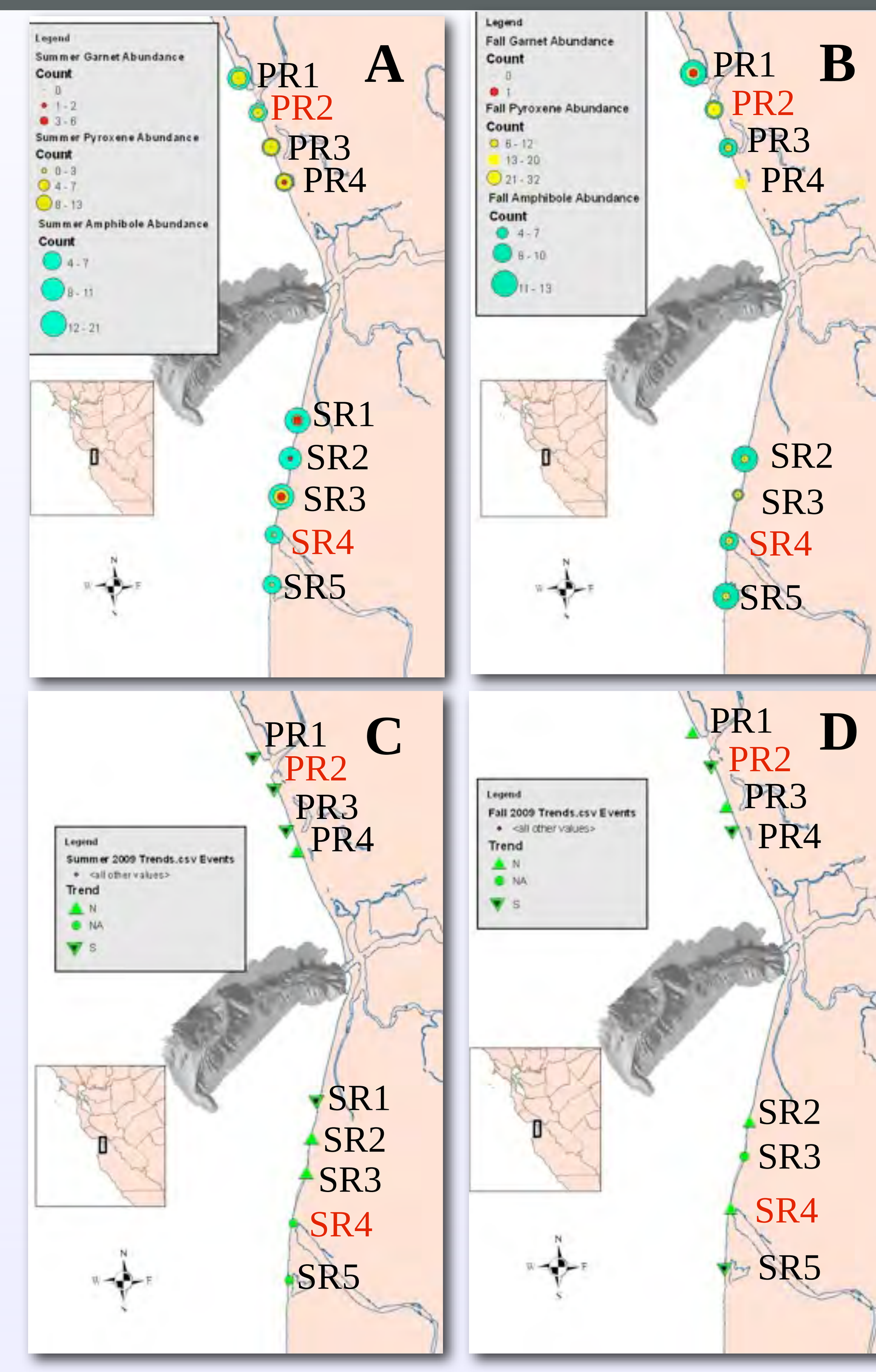


Figure 4: Heavy Mineral Abundance and Transport Trends
GIS plot of heavy mineral abundances (A-B, top right) and vector trends (C-D) for low (A, C: summer) and high (B, D: fall) wave energy conditions. Transects labeled in red denote river mouth locations.

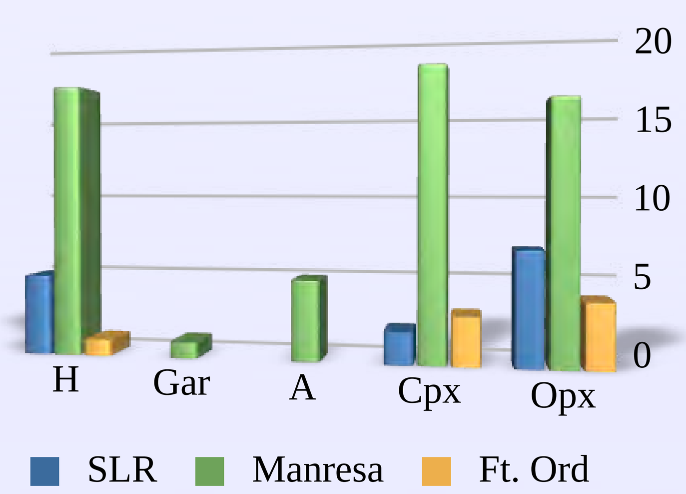


Figure 5:
Heavy mineral composition of Aromas sandstone and San Lorenzo river (SLR) sites. H = Hornblende, Gar = Garnet, A = Augite, Cpx = Clinopyroxene, Opx = Orthopyroxene

The highest abundance of heavy minerals was found in the Pajaro River mouth from January through March (Figure 6 B). Pyroxene was found in both Aromas Sandstone sites (Figure 5).

2) Seasonal Littoral Transport Trends
During summer conditions a northward transport of material from the Salinas River mouth occurred in all but one sample and a dispersion of sediment occurred to the north and south from the Pajaro River Mouth (Figure 4 C). October data indicates a northward transport of material from 1 km south of the Pajaro River (Figure 4 C). Salinas River material is transported north and south of the Salinas River. In the south bay the majority of littoral transport occurs in the northward direction (Figure 4). Winter grain size trends indicate a southward transport of material from the Pajaro River Mouth and a northward transport of sediment from the Salinas River Mouth (Figure 4 D). Three transect locations did not provide a meaningful transport vector based on the Gao and Collins (1992) model and are left as unknown vectors: SR4, SR5 and PR1. Grain size data indicates a northward transport along the coast between the northern and southern most Salinas and Pajaro transects, SR1 and PR4 (Figure 4 D).

3) Source study
Granodiorite was most common in the Salinas River samples with trace amounts of Diorite, Dacite, Granite, Arenite, Basalt and Arkose sandstones (Figure 6). Basalt rock fragments dominated the Pajaro River samples with trace amounts of Granodiorite, Andesite and Arkose sandstones (Figure 6).

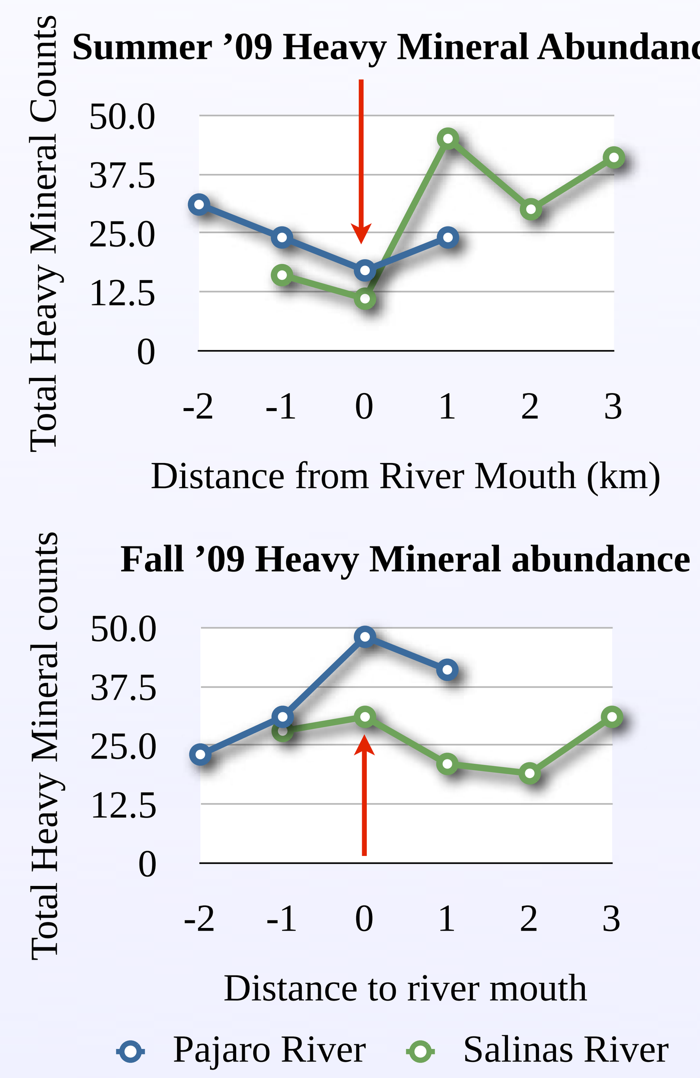


Figure 6:
Total heavy mineral counts plotted against distance from each river mouth for winter, summer and fall seasons. Distances are in km with negative values denoting transects to the south of each river mouth. Red arrows donate river mouth locations.

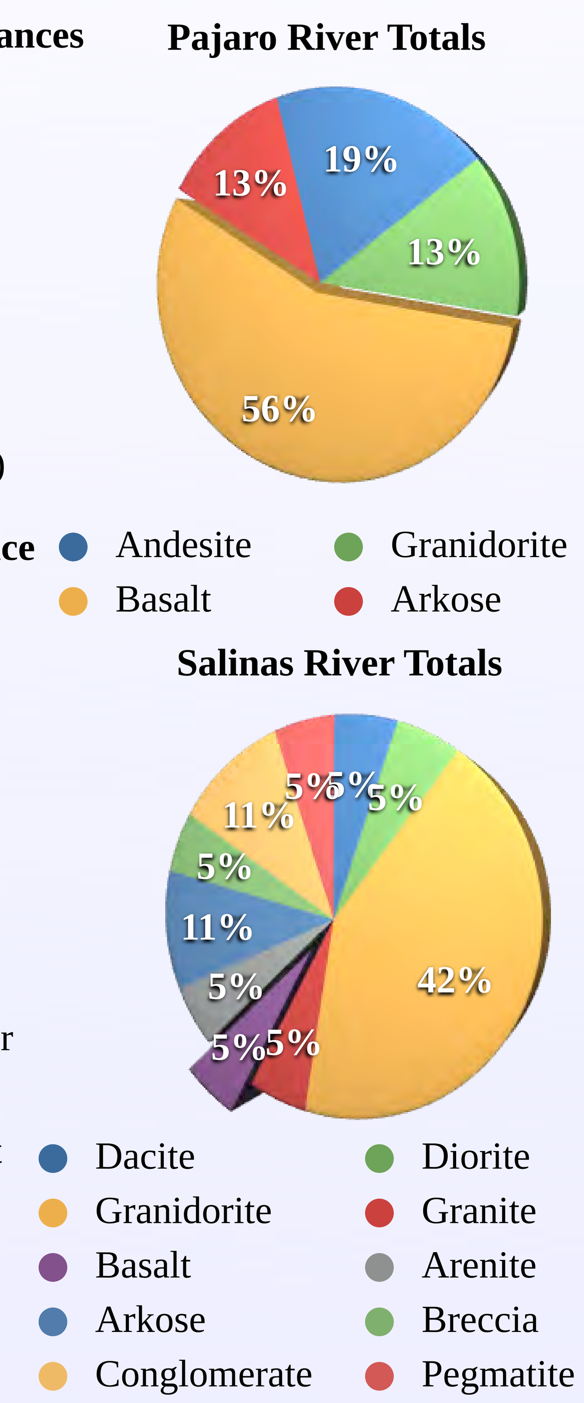


Figure 7:
Percent composition charts for both Pajaro and Salinas Rock Fragments. Change in Basalt composition is emphasized.

4. Conclusions

1. The occurrence of Pyroxene, a heavy mineral previously thought to be unique to the Pajaro River watershed ([2]), near the Salinas River in all seasons suggests that the sand supply to the central Monterey Bay beaches is probably the result of mixing between Salinas and Pajaro River material.
2. Despite a few small seasonal variations in implied littoral transport, vector plots suggest two prominent littoral transport pathways in Monterey Bay during both summer and fall seasons. Sediment is transported from the Pajaro River mouth southward; and a second littoral pathway dispersing material to the south and north of the Salinas River mouth. The existence of Pyroxene along southern sample sites supports vector data which displays a consistent southward movement of Pajaro River material.
3. The seasonal shift in heavy mineral abundance around the river mouths may be a function of off-shore bar movement (Figure 6). The Pyroxenes (dominated by Orthopyroxene) most likely eroded from composite sedimentary rocks containing Basalt, such as the Breccia and Conglomerate fragments found in the channel. A small Basalt fragment was identified in the Salinas River channel, which could be the source of the Pyroxene identified from channel and river mouth thin sections. A strong Pyroxene signature from the Aromas sandstone suggests that local erosion could be a additional source of coastal heavy mineral assemblages (Figure 5).

References:

1. Storlazzi, C.D. and M.E. Field, Sediment distribution and transport along a rocky, embayed coast: Monterey Peninsula and Carmel Bay, California. . Marine Geology, 2000. 170: p. 289-316.
2. Yancey, Thomas E. 1972. Major Heavy Mineral Assemblages and Heavy Mineral Provinces of the Central California Coast Region. Geological Society of America Bulletin 83. p.2099-2104.
3. Gao, S. and M. Collins, Net sediment transport patterns inferred from grain-size trends, based upon definition of "transport vectors." Sedimentary Geology, 1992. 80: p. 47-60.